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Discrete switching during local polarization reversal in ion sliced lithium niobate thin films

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Single-crystalline lithium niobate (LN) thin films are more attractive for optical applications compared to epitaxial and sputtering ones due to absence of light scattering at the grain boundaries. The ion-slicing is useful techniques for producing single-crystalline LN thin bonded to a SiO_2 layer on a LN substrate, called lithium niobate on insulator (LNOI) [1]. LNOI is one of the most effective structure for creation of the integrated optic devices, non-linear light converters and waveguides [2]. Modification of the LNOI films by domain engineering is very perspective topic today for increasing quality and range LNOI-based microelectronic devices.

The domain growth and interaction during local switching have been studied in the LNOI films with bottom electrode [3]. The nanodomain formation in front of the moving domain wall (discrete switching) was recently showed in such films [4]. This effect has been obtained by us in the bulk LN crystals with artificial surface dielectric layer [5]. We repeated the investigation with a wider range of the voltage pulses amplitudes and durations at different humidity. Mechanism of the domain growth and all accompanying effects were described for LNOI films.

We have studied the local domain switching in the LNOI thin films under the biased probe of atomic force microscope. Our investigation was done in the two types of LNOI wafers: (I) with the metal bottom electrode under LN film and (II) with the bottom electrode placed under the SiO_2 layer produced by Jinan Jingzheng Electronics Co (Fig. 1). The qualitative difference of the discrete switching effect in different types of LNOI wafers has been revealed. The regular nanodomain structures appeared in the first type wafers has been attributed to existence of the intrinsic dielectric layer with thickness about 100 nm (Fig. 1a). The irregular structures appeared in the second type wafers are caused by artificial SiO_2 layer blocking the forward domain growth and leading to stronger interaction of the charged domain walls. The influence of the dielectric gap thickness and tilt of the charged domain walls on the distance between main domain and its satellites was studied in detail and numerically modelled for both types of LNOI films.

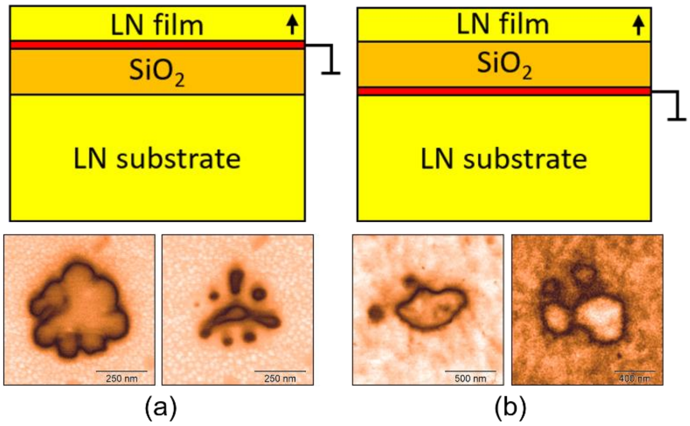

Figure 1. Typical domain shapes and schemes of LNOI wafers (a) first and (b) second types.

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